A. GENERAL

Operational procedures involve the sequence of events leading to the issuance of tropical cyclone warnings, the chief product of the Joint Typhoon Warning Center (JTWC). This includes analysis of all available data, use of forecast aids to arrive at the forecast track, and preparation and transmission of the warnings. Within the Fleet Weather Central/Joint Typhoon Warning Center (FWC/JTWC), collection and basic analysis of data is the responsibility of the FWC. This includes receipt of analyses and prognosis from Fleet Numerical Weather Facility (FNWF), Monterey through the Naval Environmental Data Network (NEDN). JTWC is responsible for meso-scale analyses, collection of reconnaissance data, making tropical cyclone forecasts, and preparation of warning bulletins. Transmission of the warnings is accomplished by the communications section of FWC, operated by the Naval Communications Station, Guam.

B. ANALYSES AND DATA SOURCES

1. FWC Analyses:

   a. Surface isobaric; 0000Z, 0600Z, 1200Z, and 1800Z.
   b. Surface isobaric, micro-analyses of South China Sea; 0000Z and 1200Z.
   c. Gradient level streamlines; 0000Z, 0600Z, 1200Z and 1800Z.
   d. 850 mb streamlines; 0000Z and 1200Z.
   e. 700 mb streamlines; 0000Z and 1200Z.
   f. 500 mb streamlines; 0000Z and 1200Z.
   g. 200 mb streamlines; 0000Z and 1200Z.
   h. Sea Surface Temperature Charts; 5-day mean and daily.
   i. Checkerboards (Stidd diagrams) of selected tropical stations.
   j. Time cross sections of selected tropical stations.
   k. Selected upper air soundings.
   l. AROWAGRAM for Guam.
   m. Nephanalyses.

2. JTWC Analyses:

   a. Sectional surface charts; hourly and 3-hourly, as required.
   b. Reconnaissance data.
   c. 700 mb meso-scale contours; 0000Z and 1200Z.
   d. 500 mb meso-scale contours; 0000Z and 1200Z.
   e. 300 mb meso-scale contours; 0000Z and 1200Z.
   f. Stidd diagram for selected stations as required when special observations are requested.
   g. 500 mb contour; Western North Pacific; 0000Z and 1200Z.

3. Satellite Data:

JTWC received excellent cloud picture coverage throughout 1967 from the ESSA II and NIMBUS satellites through the APT receiver at FWC. Gridding and display procedures have greatly improved, making these satellite cloud pictures of high value in determining formation, size, and location of tropical cyclones. The daily passes of the APT satellites received at Guam normally cover the majority of the JTWC area. In order to extend the area of coverage, an experimental exchange of satellite pictures between FWC Pearl Harbor, FWC Guam, and FWF Sangley Point over the NEDN transmission lines was begun this year. While quality has been erratic to date, the system has been useful and shows good future possibilities.

The satellite bulletins issued by the National Environmental Satellite Center (NESC) and the gridded cloud picture mosaics also originated by NESC have both been very useful. The latter cover the entire tropical Pacific Ocean and have been transmitted experimentally through the ATS satellite.

4. Land Radar:

Land radar reports are very helpful when tropical circulations are approaching or are over land areas. These reports include range and bearing of the eye from the radar station, eye characteristics, and sometimes the direction and speed of movement of the center.

5. Computer Products from FNWF, 0000Z and 1200Z:

a. Hemispheric analyses and barotropic prognoses (out to 72 hours) for surface (isobaric); 850mb, 700mb, 500mb, 300mb, and 200mb levels (contours); and 700mb, 500mb, and 300mb levels (isotachs).

b. Computer hemispheric contour analyses of 700mb, 500mb and 300mb levels are locally expanded onto large polar projection charts for the Western North Pacific area.

c. Computer analyses and prognoses of wind fields in printed format at 5 degree intervals of longitude and 1 degree intervals of latitude for 700mb and 500mb levels; Western North Pacific.

d. FNWF 500mb decomposition fields, SD, SR, and SL analyses and prognoses which correspond roughly to small scale disturbances, mean flow, and long wave pattern, respectively.

C. FORECAST AIDS

1. Climatology:

The folowing climatological publications were utilized:

a. Tropical Cyclones in the Western Pacific and China Sea Area (Royal Observatory, Hong Kong), covering 70 years of typhoon tracks.

b. Climatological Aid to Forecasting Typhoon Movement (1st Weather Wing).

c. Climatological 24-hour typhoon movement (McCabe, J. T., 1961).

d. Western Pacific Typhoon Tracks, 1950-1959 (FWC/JTWC).

e. Far East Climatic Atlas (First Weather Wing, February 1963).

f. Annual Typhoon Report, 1965 (FWC/JTWC), covering tracks for 1953-1965.

g. Annual Typhoon Report, 1966 (FWC/JTWC), covering tracks for 1965-1966.

2. Persistence:

Extrapolation of tropical cyclone tracks from past positions was always considered along with climatology in making up initial tracks and in making the "first draft", so to speak, of any forecast. Extrapolation has proven to be one of the most reliable techniques for a 12 to 24 forecast period, as shown by the JTWC computer verification program (See Chapter III).

3. Computer Products:

In addition to the computer prognoses detailed in paragraph B.5. above, forecast positions based on steering trajectories at the 1000mb, 700mb, and 500mb levels were available for 6, 12, 18, 24, 36, 48, and 72-hour positions. These steers came from the HATRACK program which is outlined in Chapter III. These forecasts were available from FNWF and were obtained after each fix was received. Toward the end of the 1967 season this computer program was adapted for running on the FWC, Guam computer on a trial basis, thus providing computer steering on a more convenient and timely basis. This should be fully operational for the 1968 typhoon season.

4. Objective Techniques:

During the 1967 typhoon season the following individual objective techniques were used by JTWC:

a. Arakawa - using surface data.

b. Tse - using 700mb data.

See Chapter III for verification of these techniques, along with verification of extrapolation, climatology, and computer steering, using the JTWC computer verification program.

D. FORECASTING PROCEDURE

In preparation for issuance of the initial warning on a tropical cyclone, a track based on climatology and extrapolation is developed for a time period of 3 or 4 days. The track is then modified in accordance with the existing and forecast upper air patterns. Numerical steering forecasts and objective techniques are also considered before the initial warning is issued.

Subsequently, the basic track is modified as dictated by consideration of all forecast aids. For each forecast, extrapolation is checked against climatology, objective techniques, and numerical steering forecasts, with extrapolation being favored for a 12 to 24 hour period. Subjective modifications are also based on meso-analyzed 700mb, 500mb and 300mb charts and on numerical hemispheric prognoses. 200 mb streamline analyses provide indications of divergent areas relating to changes in intensity.

The resulting forecast track is thus a subjective integration of these many factors, with extrapolation and numerical steering being most heavily weighted for short period forecasts, while climatology and forecast flow patterns govern the longer range outlooks.

E. WARNINGS

In the JTWC area of responsibility, tropical cyclone warnings are issued at 0000Z plus every six hours. In accordance with CINCPAC INST. 3140.1H, the warning message contains the position of the tropical cyclone which is valid for the scheduled transmission time. Therefore, the 24-hour and 48-hour forecasts are actually 30-hour and 54-hour forecasts from the last available synoptic data.

The warning position of a tropical cyclone is actually a short range forecast from the last "best" position. The last "best" position is usually about 2 hours old based on land radar or reconnaissance fixes, 3 to 6 hours old based on surface synoptic reports, or 6 to 12 hours old based on upper air synoptic reports. It is for this reason that the 0600Z warning, for example, may not agree with the position of the tropical cyclone as indicated by the 0600Z analysis. Amendments are issued when this difference is significant.

The numbering of tropical cyclone warnings runs consecutively regardless of whether the cyclone is upgraded or downgraded from one stage to another. If warnings are discontinued and the circulation regenerates, the new series of warnings are numbered consecutively from the number of the last warning of the previous series. Amendments and corrections which are issued as required are given the same numbers as the warnings which they amend or correct.

When tropical cyclones become extratropical before dissipating, a final warning is issued by JTWC and extratropical warning responsibility is transferred to the appropriate Fleet Weather Central.

All 24, 48, and 72-hour forecasts made when a tropical cyclone is of tropical storm or typhoon intensity are verified against the "best track" as determined by post-analysis. The 1967 verification summary is contained in Chapter IV.

In addition to the tropical cyclone warnings, JTWC issues a prognostic reasoning twice daily for a 72-hour period for tropical storms and typhoons. A tropical weather summary for the JTWC area of responsibility is issued each day at 0600Z from 1 May through 31 December.